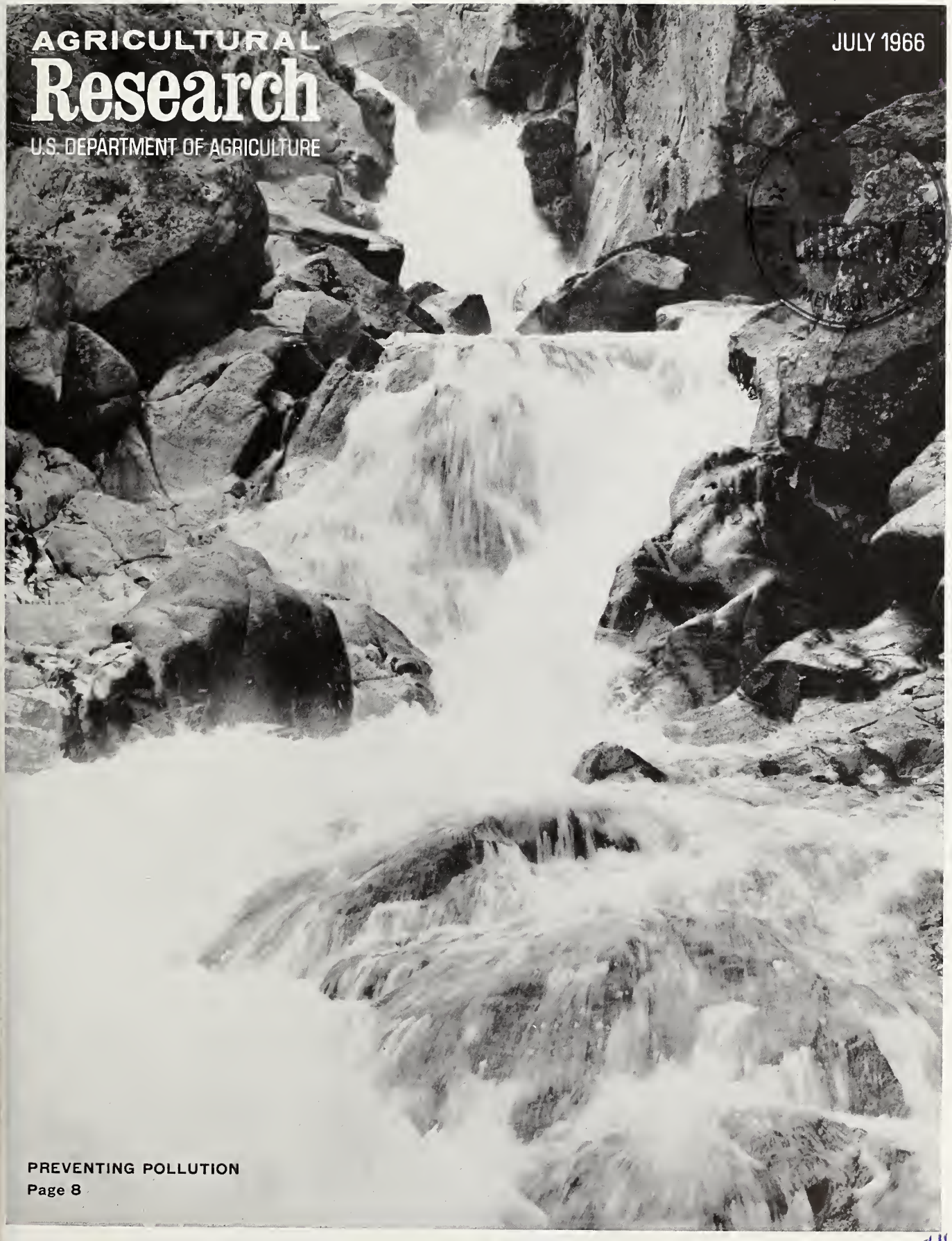

AGRICULTURAL
Research
U.S. DEPARTMENT OF AGRICULTURE
JULY 1966
PREVENTING POLLUTION
Page 8

AGRICULTURAL
Research

July 1966/Vol. 15, No. 1

Preventing Pollution

"We must undertake a cooperative effort to end pollution . . . to make the waters of entire river systems clean."

With this challenge in his 1966 State of the Union Message, President Johnson redirected attention to a problem—water pollution—as old as history.

Centuries ago, the Indus civilization, one of the world's three earliest great cultures, flourished in what is now West Pakistan. Archeologists now believe that its downfall a few centuries after 2000 B.C. was caused by river pollution. Mud, silt, and sand dammed the Indus River, which overflowed and inundated farmland and cities.

More than 150 years ago in this country, pollution by sediment forced a change in the design of the sailing craft that plied the Chesapeake Bay. As sediment washed down rivers and creeks and choked the Bay, harbors became so shallow that by 1815 the deep-hulled vessels formerly used were virtually abandoned.

Today, sediment ranks with domestic and industrial wastes as a major source of water pollution. Every year, sediment deposited in major reservoirs reduces this Nation's water supply by the amount needed by a city of 5½ million.

A problem 4,000 years old cannot be solved overnight. ARS research, however, has aided in reducing sedimentation and in preventing, reducing, or eliminating other water pollution. (See pages 8–11.)

Research continues at field stations where ARS scientists, working under a variety of local conditions, try to solve specific water pollution problems.

Basic research on pollution through sedimentation is underway at Oxford, Miss. Here, soil scientists, geologists, and engineers at ARS' Sedimentation Laboratory study such questions as how sediment is made and how it moves. Thus, they hope to better control the conditions that lead to sedimentation.

Such research is vital, not only to keep abreast of the growing problem of water pollution, but eventually to realize the goal set forth by President Johnson: To make our waters "a source of pleasure and beauty for all our people."

Editor: R. P. Kaniuka
Managing Editor: H. K. Street
Contributors to this issue:
R. J. Anzelmo, G. W. Beshore, V. E. Bourdette, H. L. Brinson, E. H. Davis, A. J. Feeney, D. W. Goodman, K. D. Goodrich, M. E. Haun, M. B. Heppner, K. M. Horne, J. G. Nordquist, N. E. Roberts, J. M. Singer, D. F. Warren, J. H. White

AGRICULTURAL RESEARCH is published monthly by the Agricultural Research Service, United States Department of Agriculture, Washington, D.C., 20250. Printing has been approved by the Bureau of the Budget, August 15, 1958. Yearly subscription rate is $1 in the United States and countries of the Postal Union, $1.50 in other countries. Single copies are 15 cents each. Subscription orders should be sent to Superintendent of Documents, Government Printing Office, Washington, D.C., 20402.

Orville L. Freeman, Secretary
U.S. Department of Agriculture

G. W. Irving, Jr., Administrator
Agricultural Research Service

Extract From Chinese Tree Shows Promise for

LEUKEMIA CONTROL

A SUBSTANCE EXTRACTED from the fruit, bark, wood, and twigs of an obscure Chinese tree may have promise for arresting leukemia in humans.

It has shown high antitumor activity in tests on laboratory animals with a type of experimental leukemia, called Lymphoid Leukemia L–1210.

More research is needed before the substance, called camptothecin, can be tested on human patients. The only known source is the tree *Camptotheca acuminata.* Chemists are trying to synthesize the material. If they are not successful, and if camptothecin continues to show promise for combatting leukemia, the tree might become a new crop for American farmers.

Camptothecin was isolated and tested as part of an intensive program in which ARS botanists, supported by funds from the Cancer Chemotherapy National Service Center of the National Cancer Institute, are searching the world's plant resources for possible anticancer substances (AGR. RES., May 1966, p. 3).

ARS collects and identifies plant samples, and scientists working under National Cancer Institute contracts extract and test chemicals for antitumor activity. A team led by chemist M. E. Wall at the Research Triangle Institute, Durham, N.C., isolated and identified Camptothecin.

Seed of *Camptotheca acuminata* was collected in 1933, however, long before the current program started. Collaborator A. N. Steward forwarded the seed from China for identification and planting as part of a long-term ARS plant introduction program.

Had the identity of Steward's seed been known at the time of receipt, it

PRODUCT OF WORLD PLANT SEARCH

Camptotheca trees planted at Chico, Calif., in 1963 are now about 7 feet tall. (*Photo No. PN–1381*)

Flowers (*left*) *and developing fruit* (*center and right*) *of the Camptotheca tree.* (*Photo No. PN–1382*)

LEUKEMIA CONTROL

(Continued)

probably never would have been planted, botanist R. E. Perdue, Jr., who leads the ARS collection program, says. *Camptotheca* had been introduced on two earlier occasions but the trees proved of little interest or value. The seed was planted. however, and several plants were forwarded to the ARS Plant Introduction Station, Chico, Calif. Two trees, now 25 feet tall, survive at Chico.

When the current program got underway in 1960, many old extracts including one made of *Camptotheca* leaves in 1950, were tested. This extract was active against tumors, but the supply was not adequate to complete testing.

The Chico Station provided new samples of leaves and twigs in May 1961. These and similar samples collected in September 1961 were inactive. But fruit also collected then passed tests for antitumor activity. Extracts from bark and wood samples also showed antitumor activity in later tests.

By late 1963 intensive chemical research was under way to isolate and identify the substance responsible for *Camptotheca's* antitumor activity. It was evident that the two Chico trees would not provide enough raw material to complete the tests unless they were both removed. These trees were spared, however, since they were the only known source of seed for propagation.

ARS botanists searched the west coast for additional *Camptotheca* trees, and found a few, most of them fairly small, scattered from central to southern California. They provided additional material for the chemical research.

During the fall of 1963, ARS horticulturist R. L. Smith began germinating seeds from the trees at Chico. *Camptotheca* seed germinates readily, and seedlings about 18 inches tall provided workable quantities of camptothecin by September 1964.

A new planting of 1,300 seedlings was established at Chico this spring. In 2 years, this new planting will provide a significant new supply of raw material.

Horticulturists at Chico are learning as much as possible about the agronomic performance of *Camptotheca*, including effects of fertilization, spacing, and other factors.

Perdue believes that American agriculture can produce an adequate supply of *Camptotheca*. If the material is needed, scientists will work toward developing faster growing varieties that will yield larger amounts of camptothecin.

ARS plant introduction specialists will also attempt to find new *Camptotheca* germ plasm in foreign botanical gardens in the hope that plants of different genetic stock will yield larger quantities of camptothecin. ■

Twigs and flowers of Camptotheca acuminata have provided extracts that have shown high activity in tests against leukemia in laboratory animals. (Photo No. PN–1383)

LEUKOSIS RESEARCH YIELDS CLUES FOR HUMAN CANCER STUDIES

RESEARCH ON AVIAN LEUKOSIS is helping medical scientists trying to solve the riddles of human cancer.

The two diseases are similar, although the poultry disease does not infect humans. There is strong circumstantial evidence, but no clear proof, that a virus causes human cancer. That virus, if it existed, would be a near-relative of the viruses that cause avian leukosis.

Scientists thus gain clues that aid in their search for the human cancer virus from knowledge of this poultry disease. Experience gained in trying to control avian leukosis will help in curbing the human cancer virus when—and if—it is discovered.

ARS scientists at the Regional Poultry Research Laboratory, East Lansing, Mich., are among the leaders in avian leukosis research. They helped establish the fact that a filterable virus causes avian leukosis, and took part in studies during which the causative viruses were spotted through a high-power electron microscope and followed on their path from cell to cell in infected chickens. Now, the size, shape, structure, habits, weaknesses, ways of travel, and modes of action of avian leukosis viruses are known.

Recently, the ARS workers helped show that one group of viruses involved in the disease lacks the protein coat which all viruses seem to need to infect chicken cells. These "defective" viruses spread by sharing the coats of other viruses that infect chicken cells. Since the coatless viruses by themselves appear noninfective, scientists think that the virus presumably involved in human cancer uses a similar dodge to appear to be harmless.

There are indications that the pattern of spread of avian leukosis resembles that of cancer. The ARS poultry scientists found that specific types of tumors occurred more often in chickens of specific ages. Certain forms of human cancer similarly are most prevalent among people of certain ages. Children 3 to 4 years old, for example, most frequently fall victim to the blood cancer, acute leukemia.

Usually only a few chickens in a flock infected with leukosis show disease symptoms. Human cancer also occurs without apparent contact between patients.

The poultry scientists found that a day-old chick can carry billions of leukosis viruses in its body, yet live out a normal lifespan without developing disease symptoms. Cancer researchers suspect that the supposed virus that triggers cancerous growth in humans is present generally in the population—but affects only about 6 people out of 100,000.

Another ARS discovery raises the possibility of vaccination against cancer if a virus is proved to be the cause. The poultry scientists found that hens experimentally injected with leukosis virus produced baby chicks resistant to the disease. Antibodies to leukosis were apparently passed from parent through egg to offspring, even when hens were vaccinated with a dilute preparation of leukosis virus. To date, a vaccine for avian leukosis has not been developed because so many virus strains are involved.

Studies on the role of glands in triggering or preventing leukosis in chickens have led to research on the influence of glands on the incidence of human cancer. Possible anticancer agents have also been screened in chickens; none so far has proved to be an effective preventive or cure. ■

At New Beltsville Lab, Scientists Will Study—

What Makes Plants Resistant

Soybeans are among the plants M. E. Mace and his coworkers will use to study resistance to insects and diseases. (Photo No. ST–1058–16)

TWO LINES SELECTED from the soybean variety Clark are identical except for one vital characteristic: One line is susceptible to bacterial leaf-spot; the other is resistant.

But what is the *basic* difference between them? *Why* is one susceptible and the other resistant?

Answers to these and similar questions about the basic nature of resistance in plants to attacks of specific diseases and insects may lead to ideal solutions of many plant disease and insect problems.

By gaining a basic understanding of resistance, plant breeders may be able to incorporate genetic sources of resistance in new varieties more rapidly and effectively than at present.

With a basic understanding of the biochemical processes that occur when a pest attacks a plant, scientists may be able to design compounds that will repel, kill, or interfere with the reproduction of that pest without affecting the plant or anything else in the environment.

ARS scientists are learning how plants resist disease at a new Pioneering Research Laboratory at Madison, Wis. (AGR. RES., January 1966, p. 16) and at a laboratory just established at Beltsville, Md. The two laboratories maintain close liaison.

Scientists of many disciplines will staff the Beltsville laboratory, directed by plant pathologist M. E. Mace. With a multidiscipline team approach, Mace hopes the group will avoid situations in which a scientist turns up a promising lead, then has to drop it because it is out of his particular sphere of competence.

For instance, the plant morphologist might detect gross changes in the mitochondria (tiny cellular bodies important in converting food energy into a more readily available form) in diseased plants. The physiologist and biochemist could follow up this find.

The plant pathologist might detect abnormalities in the distribution of an enzyme system or other chemical materials at the cellular or tissue levels. This could provide a valuable lead for studies inside the cell by the physiologist and biochemist.

At first, the Beltsville laboratory will be staffed with a plant physiologist, a plant biochemist, a plant morphologist, and a microbial physiologist, who will concentrate largely on studies of disease resistance. Four more scientists will be added later to expand studies on the nature of plant resistance to insect attack.

Although the basic nature of disease and insect resistance in plants is not yet well understood, Mace and his coworkers believe there are several worthwhile approaches. Among them are the auxins and phenols and their relation to disease resistance.

Auxins, a class of plant hormones, appear to be involved in wilting of tomato plants infected by bacterial or fusarial wilt pathogens. They cause abnormal growth in the xylem or water conducting tissue. If scientists understood *how* the pathogens stimulate production of excess auxins, they might be able to stop the process.

The phenols present in diseased plant tissue are often toxic to the pathogen causing the disease. Research may show whether a plant's ability to produce a large amount of a phenol in the presence of a pathogen is a resistance factor.

In trying to learn more about what makes certain plants extremely attractive to insects, the scientists may study plants such as smartweed that are highly attractive to the Japanese beetle. If a chemical in these plants can be isolated and identified as an attractant or vital nutrient, it might trap beetles or other insects. ■

With Sterility Technique

Screwworms
Eradicated from U.S.

THE SCREWWORM has been eradicated from the United States. This marks the first time that a wide-ranging insect species has been eliminated from this country using sexual sterility as the eradication tool. The screwworm literally was caused to destroy itself.

Less than a decade ago, screwworms were one of the most serious livestock parasites in the United States, causing annual losses of up to $100 million to domestic animals and untold losses in wildlife. Historically, the insect has menaced warm-blooded animals throughout the Southern United States, spreading northward during warm seasons.

Eradication came after 5 years of intensive State-Federal effort in two separate campaigns: In the Southeastern United States during 1957–59, and in the Southwest from 1962 to the present. About $32 million went for eradication and protection costs—about one-third the cost of damage that screwworms can cause in one bad year.

Weapons for the battle were acquired when ARS entomologists discovered a practical way to sexually sterilize screwworms and learned how to raise them in large numbers. ARS veterinarians applied these laboratory findings to the large-scale eradication campaigns involving the release of more than 20 billion sterile screwworm flies to cause infertile matings and eventually eliminate the native population.

These campaigns required mass production of insects on a scale never before attempted. The huge production plant now operating at Mission, Tex., is a marvel of biological mechanization tailor-made to fit the screwworm's life cycle. The plant employs around 300 persons and operates 24 hours a day to produce up to 150 million sterile screwworm flies each week. Screwworm larvae can devour, each week, around 70 tons of meat and 12,000 gallons of blood. They are sterilized in the pupal stage by exposure to radioactive cobalt. The pupae are packaged in cartons where they develop into flies, then released from aircraft.

This spring, California and Arizona were declared free of established screwworm populations, thus making the entire United States free of established native screwworms. But migrating screwworms from Mexico cause concern. The screwworms' explosive ability to multiply and spread makes it vital to detect migrant infestations early to prevent establishment of the insect.

To protect the Southwest from Mexican screwworms a barrier has been established through release of millions of sterile screwworm flies over Northern Mexico. Barrier activities, cooperatively carried on with the government and livestock producers of Mexico, have lessened screwworm damage in northern Mexico and stimulated interest in extending the campaign.

Livestock producers of the Southwestern United States and Mexico have formally requested that both countries conduct a joint screwworm eradication program in Mexico. They point out that such a program would better protect screwworm-free areas of the United States, and cut costs of operating the barrier, which could then be established across a narrower section of Southern Mexico.

The success of screwworm eradication in the United States has stimulated research on turning the sterility concept—using either irradiation or chemicals—against other insect pests. It has helped wipe out the melon fly on the Pacific Island of Rota and the oriental fruit fly on Guam. It is in use along the California-Mexico border against the Mexican fruit fly, and researchers in Egypt, Israel, and Central America are trying it against the Mediterranean fruit fly. And in Africa, scientists are testing the sterility technique against the tsetse fly, a pest that spreads sleeping sickness and retards development of major portions of Africa. ■

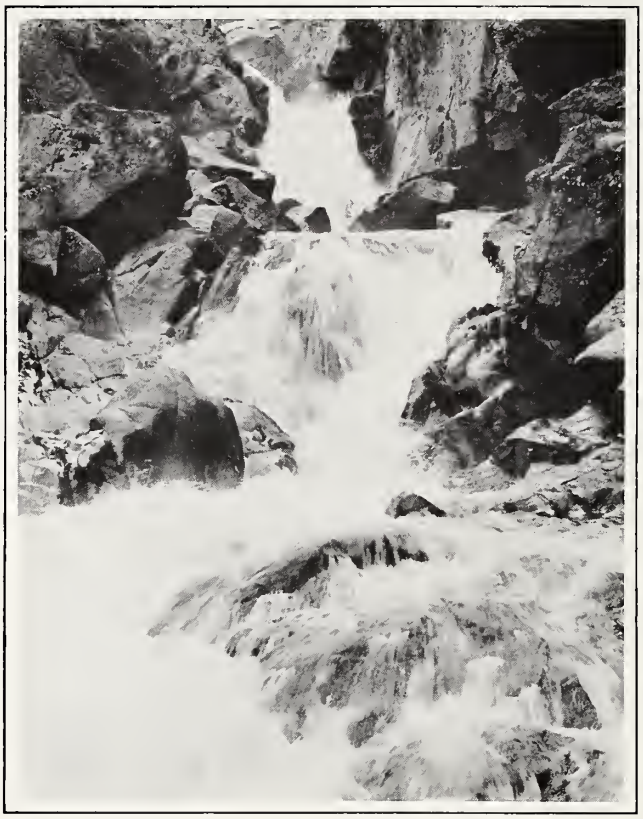
The screwworm rearing plant at Mission, Tex., can mass-produce up to 150 million sterile flies per week. (Photo No. BN–24921)

PREVENTING POLLUTION of this Nation's lakes, streams, rivers, and other water supplies is a major objective of ARS research.

The problem is under attack along many fronts. Currently, for example. ARS scientists are:

- Developing new ways for preventing the erosion that leads to pollution through sedimentation.
- Conducting basic studies on how sediment is transported and distributed in stream channels, lakes, and reservoirs in order to devise improved methods of sediment control.
- Studying the movement of agricultural chemicals—pesticides and fertilizers—from the land to streams by overland and subsurface routes.
- Studying techniques for protecting our water supplies from farm and industrial wastes.

These are among the results of ARS research aimed at preventing pollution:



In Broad Research Effort

ARS WORKS TOWARD PREVENTING POLLUTION

An extensive monitoring program established by ARS determines how much pesticide residue, if any, gets into streams and rivers, and its possible effect on the environment.

At six monitoring sites throughout the country, scientists study water runoff and sedimentation from large-scale farming areas where pesticides have been applied extensively.

Their findings on the fate of pesticides may serve as a basis for developing pesticide materials and application methods that will eliminate residues or hold them at low levels.

Pilot study in the Mississippi River Delta, an area with a long history of heavy pesticide use by farmers, preceded the establishment of the nationwide program. That study indicated no large, progressive buildup of organic pesticides in soil, sediment, and water in the region.

ARS has also monitored Federal-State insect control programs and found little or no effect on wildlife from the large-scale application of insecticides.

Controlling streambank erosion with specially designed concrete blocks that resemble waffles can help reduce the estimated 1½ billion cubic yards of sediment deposited each year by the erosion of 10 percent of the banks along the Nation's 1½

million miles of stream channel.

The blocks, which are 4 inches thick, 16 inches wide, and 24 inches long, are less likely to wash away than 18-inch stone riprap commonly used to control streambank erosion. They are lightweight, convenient to handle, and fit together to form a flexible mat that conforms to grade changes. Each block has 2 dozen 2-by 2-inch holes which can hold gravel or crushed rock against the bank or can be planted with grass or shrubs to help hold the soil.

The blocks, installed along 20 percent of the banks of Buffalo Creek in New York State, reduced the sediment load carried by the creek by 40 percent, and survived five floods in 8 years with very little damage.

The concrete blocks, if commercially produced, would cost about the same as stone riprap, if the stone is available locally.

Adding citrus molasses to citrus pulp, then drying the mixture, produces a nutritious animal feed and eliminates a serious waste disposal problem.

Both the molasses and the pulp are byproducts of the citrus processing industry. The pulp was normally converted to animal feed, however, while the 50,000 tons of molasses produced annually piled up when it could not compete in price with blackstrap molasses.

Attempts were made to dispose of it in pits, but odors developed and the molasses percolated through the soil to contaminate lakes and streams in citrus-producing areas.

ARS scientists found that the molasses could be dried on citrus pulp without causing significant changes in the storage characteristics of the pulp.

An average of about 35,000 tons of citrus molasses is now dried on citrus pulp each year. The feed produced is more nutritious and is worth $10 more per ton than ordinary citrus pulp.

Detergents from animal fats, developed originally with the hope of creating a new market for the tallow that was once used in large quantities for making soap, now have an unexpected potential for reducing stream pollution.

When petroleum-based detergents—specifically the most widely used ones, alkylbenzenesulfonates (ABS)—were recognized as one cause of the billowing foam that blanketed our waterways, ARS scientists took another look at the tallow-based detergents they had developed years before. These had not been widely accepted commercially because they were higher in cost than those made from petroleum.

Tests showed, however, that the detergents from tallow were more easily broken down in sewage treatment plants than either ABS or other compounds since developed by the petroleum industry. Some fat-based detergents break down under anaerobic conditions, such as in cesspools—those made from petroleum do not.

Disposing of dairy wastes can be done safely if the waste waters are aerated by an economical system developed by ARS scientists. The system was originally designed to treat one of the most troublesome of food wastes, the water used for sanitation and cooling in dairy plants.

ARS researchers first produced a laboratory-scale process based on their analyses of the biological oxygen demand of these wastes, then supervised USDA contract research on making plant-scale runs. When the method was proved to be effective and economical, the process was installed by a number of dairies.

The process has since been adapted to treating all types of wastes—municipal, canning, cosmetic, citrus, and even textile and petroleum wastes. Package aeration plants capable of treating 2,000 to 200,000 gallons a day are now commercially available. Installation costs about a dollar per gallon of waste treated per day.

Flowering and ornamental plants usually grown in home gardens and landscapes can also control erosion and beautify highway embankments.

Old and newly cut highway embankments are a major source of sediment in urban areas. For example, in ARS tests, an unprotected roadbank lost about 450 tons of soil per acre per year. But when crownvetch—a perennial legume with clusters of lavender to white blooms—was established on the bank, erosion was completely controlled.

ARS scientists tested over 35 species of annual and perennial plants on about 2,500 roadbank plots of different soils and exposures. Test plants included daylilies, iris, yellow jasmine, English ivy, and periwinkle as well as honeysuckle, broomsedge, and other native plants. All effectively controlled erosion from highway cuts and fills.

Crownvetch, the scientists say, is

one of the most promising plants tested. It remains green most of the year, has attractive sweetpea-like blooms, and spreads from rhizomes, or underground stems. It is slow to get started, but if seeded in a nursecrop of grass—such as Abruzzi rye, common Bermuda, lovegrass, Kentucky 31 fescue, or lespedeza sericea—it will germinate and take over as the nursecrop dies out.

Insect control methods that reduce or eliminate the need for chemicals help prevent water pollution by minimizing pesticide use.

Light traps and sex attractants are being studied for use in conjunction with chemosterilants or pesticides. This technique draws insects to the chemical, thereby restricting pesticide use to a small area.

The sterile male release technique offers potential for controlling insects without pesticides. Male insects are reared, sterilized, and released to mate with the normal population, thus controlling the target species without pesticides.

ARS scientists are also testing disease agents for insect control. Viruses and bacteria have been used successfully in tests that involved rearing insects, infesting them with viruses, and then turning them loose to infest natural populations. Further testing will be conducted to assure the safety of this technique.

Tons of poultry feathers that were once disposed of in streams and rivers are now a multi-million-dollar-a-year business, as a result of ARS and State agricultural experiment station research which developed a process for converting the feathers into meal.

Feather meal supplies producers with a feed product that contains more protein per pound than any other available material, leaving more room in rations for high-energy ingredients.

Processing the meal is a low-cost operation for renderers. Broiler feathers are in continuous supply. Equipment consists chiefly of a steam pressure cooker and grinders which are used in other rendering operations.

Foam-drying whey converts an expensive waste, once disposed of in streams and rivers, into a profitable byproduct. The 9 pounds of watery whey left over from every pound of cheese made can constitute a serious river pollutant.

ARS developed a foam-spray process for drying whey. The result—a nutritious product useful in making cookies, sherbets, puddings, ice lollipops, and other foods, as well as a valuable animal feed. Even the highly acid whey from cottage cheese can be dried by this process. ARS scientists have also shown that whey can be converted to yeast.

Engineer Designs

An ARS agricultural engineer is developing a system for using livestock wastes to grow forage grasses for hay, silage, or green chop—and at the same time prevent these wastes from polluting water supplies.

Waste disposal is a major and often unsolved problem for the increasing number of farmers who raise cattle, hogs, and poultry in confinement.

These wastes may enter lakes, rivers, and streams. The fertilizer nutrients in the wastes help the growth of aquatic weeds. The water thus becomes unsuitable for many uses, and serves as a breeding area for insects and diseases.

The pilot system designed by H. J. Eby at Beltsville, Md., in cooperation with the University of Maryland, College Park, traps the effluent from a manure lagoon in a series of three hydroponic beds. Each bed contains grass roots distributed through a

RIGHT—In system Eby designed, wastes flow by gravity through overflow pipe of manure lagoon (at left) and through fine gravel in hydroponic beds 1, 2, and 3 in sequence. Grass roots in beds trap the nutrients in the effluent.
(Photo No. PN–1384)

HYDROPONIC SYSTEM

For Growing Forage Grasses With Livestock Wastes

layer of fine gravel.

Effluent flows in turn, into the first, second, and third bed in the series. In each bed, the grass uses the nutrients in the wastes.

For farm use, each hydroponic bed will be about 1½ feet deep, and will be lined with polyethylene film to prevent seepage. Eby estimates that for every 100,000 gallons of effluent discharge, 2.2 acres of land will be required for the beds.

So far, the engineer has conducted only laboratory tests. For further testing, he has built a hydroponic system on the farm of a Maryland dairyman who is using a lagoon for disposing of milking parlor and washroom wastes.

Eby previously designed a system of tanks for chemically treating liquid livestock wastes for possible reuse (AGR. RES., January 1964, p. 13).

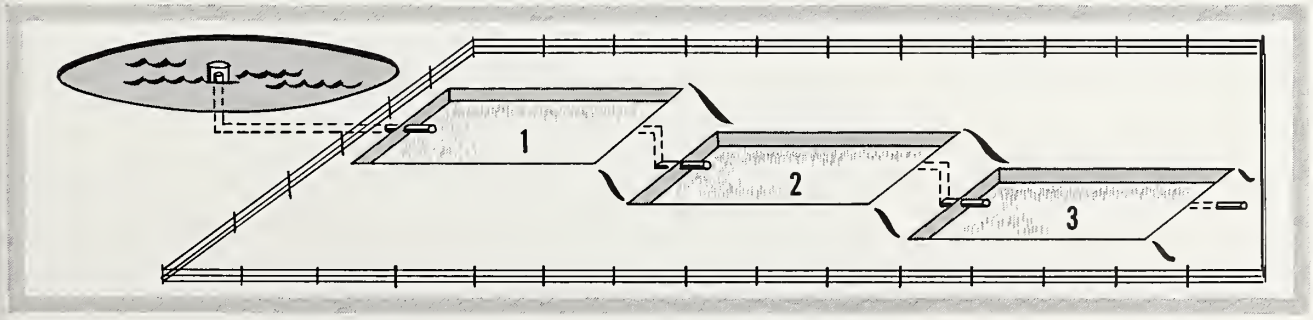
In this system, liquid and solid wastes are flushed into a collecting tank. Solid wastes settle to the bottom, and liquid is siphoned into a treatment tank where a chlorinating chemical is added automatically. The liquid then drains into a third tank, where it is filtered through a fiberglass screen and about 24 inches of coarse construction sand. Clear water then drains from the filter tank into the stream—or it may be piped into an underground storage tank.

The collection and treatment tanks have drains for drawing off the settled waste materials, which can be spread over fields or buried. Eby estimates that treatment would cost about 25 cents per 1,000 gallons of clarified liquid.

Before reuse, Eby cautions, the bacteria content of the water would have to be determined, and approval by local health authorities would be required. ■

TOP—Agricultural engineer H. J. Eby shows the height of forage grasses grown in farm waste runoff 26 days after first cutting. (Photo No. ST–941–1)

ABOVE—Laboratory technician Grover Sherlin tests forage to determine its water content and suitability for hay, silage, or green chop. (Photo No. ST–942–9)



With Interchangeable Nozzle Systems—

VERSATILE SPRAYER DEVELOPED FOR LOW-VOLUME APPLICATION

A VERSATILE LOW-VOLUME ground sprayer with interchangeable nozzle systems that can be switched in a few minutes is being developed by ARS scientists at Tifton, Ga.

The sprayer can be adapted quickly and easily for experimental use with different insecticides and different rates of application—an advantage over other experimental low-volume ground sprayers.

In low-volume spraying, a small amount of undiluted insecticide is applied to each acre, compared to conventional spraying which uses insecticides diluted with large volumes of water or oil.

ARS originally developed low-volume spraying for use with aircraft. Scientists are now developing low-volume ground sprayers suitable for use on small acreages.

Agricultural engineers E. A. Harrell and W. W. Hare and entomologist J. R. Young built their sprayer for use in sweet corn pest control studies in cooperation with the Georgia Coastal Plain Experiment Station.

Parts for their 4-row machine cost about $300. They believe that a sprayer using the principles of their machine could be manufactured for farm use.

On their sprayer, one nozzle system is capable of spraying insecticides at rates of 1 gallon or more per acre. Compressed air forces liquid from the insecticide tank through the nozzles in one operation.

The other system is capable of spraying at rates lower than 1 gallon per acre. Compressed air at a low pressure forces liquid from the tank up to the nozzles, where a high-pressure air stream flowing directly from the compressor atomizes and disperses the spray.

The sprayer is mounted on a high-clearance tractor to avoid injury to corn as the unit moves through the field. Spray nozzles are mounted on bars that can be adjusted to place chemicals above the corn or at equal distances between rows at ear height.

Other experimental low-volume sprayers developed by ARS include:

- An aerosol sprayer which uses a compressed-air spray gun and a compressor driven by a 1-cylinder engine, both mounted on the rear of a small farm tractor. Spray is released below a weighted plastic canopy. Back pressure keeps the finely atomized spray droplets from touching the canopy and deflects them onto crop foliage. Scientists at Beltsville, Md., built the sprayer from parts that cost about $100 (AGR. RES., July 1965, p. 12).
- A spinning disk sprayer developed cooperatively by scientists at State College, Miss. Compressed air forces concentrated insecticide through nozzles onto rapidly spinning stainless steel disks, then onto the crop. Disks are powered by a 12-volt electric motor and are so arranged that spray material which splashes off one disk hits another. The sprayer is mounted on a high-clearance tractor. Parts cost about $200.
- A mist sprayer, cooperatively developed by entomologists at Florence, S.C. It uses mini-spray nozzles, designed originally for low-volume aerial spraying, to break up undiluted insecticide into fine particles. In aerial spraying, the air stream set up by the plane's forward motion disperses the spray. For this ground sprayer, a mist blower produces the air stream. It is mounted on a high-clearance tractor. Parts cost less than $750 (AGR. RES., October 1965, p. 5). ■

Experimental low-volume sprayer, mounted on high-clearance tractor, has spray nozzle positioned above corn. Nozzles can also be lowered to place spray between rows. (Photo No. PN–1385)

island provides control

St. Croix Chosen for Test of Blacklight Traps

Entomologists know that blacklight is so attractive to tobacco hornworm moths that they will fly headlong toward the light—and into traps.

They don't know, however, whether blacklight traps catch enough moths to justify recommending that farmers install traps in community or regional efforts to control hornworms.

Results of North Carolina tests during the past 4 years suggest that these traps provide effective control, but remain inconclusive because moths from nearby areas fly into the test area.

An ARS test started in May should overcome this problem. It is on St. Croix, one of the Virgin Islands, about 60 miles southeast of Puerto Rico, and at least that far from other islands.

Because the island is isolated, outside moths cannot fly in. Its size, about 80 square miles, is also ideal for research to determine precisely how effective blacklight traps are for tobacco hornworm control.

The tobacco hornworm is one of the most destructive pests of tobacco in the United States, and also damages tomatoes and several other crops. Tobacco hornworms exist on St. Croix although no tobacco is grown there.

Entomologist A. H. Baumhover leads the trapping investigations. Agricultural engineer J. M. Stanley directed installation of the light traps and will supervise their operation.

Use of blacklight traps is a variation of an insect control concept known as total population suppression. Its objective is control of the entire population of an insect species on a community, regional, or national basis. The method would do little or no good if used by individual farmers.

St. Croix is large enough for valid testing of the total population suppression approach, yet is small enough to make testing economically feasible.

There are 240 traps on St. Croix—about 3 per square mile. Tests can continue nonstop as hornworm moths are active throughout the year.

At first, blacklight traps will be the only control method tested on St. Croix. After the effectiveness of this method is determined, the combination of light traps and living virgin females will be tested. Recent ARS tests in North Carolina showed that placing virgin females near the traps increased the catch of males.

Scientists want to determine if baiting traps with virgin females will reduce male numbers enough to prevent or significantly reduce reproduction.

The North Carolina tests also revealed that blacklight trapping apparently reduced the tobacco budworm population. Scientists aren't sure, however, whether this reduction was due to light trapping, cultural control, or both. Experimental conditions on St. Croix will provide more accurate answers to this question. ■

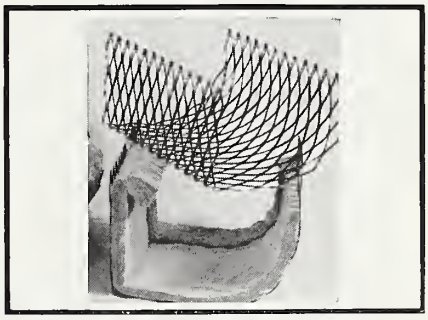
NEW COTTON BATTING REGAINS MARKETS

Improved cotton batting developed by ARS is regaining markets lost to other upholstery materials.

It is more resilient than ordinary cotton batting, and can be molded to any desired shape during manufacture. The new cotton batting is also less expensive than competitive padding materials such as synthetic fibers and foam rubber.

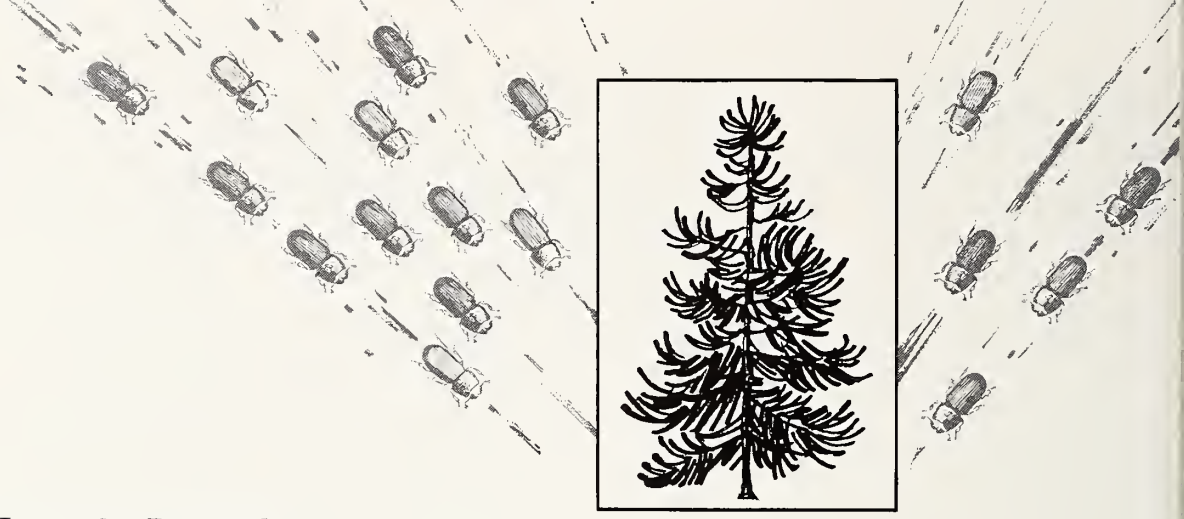
The new product, trade named "Cotton Flote" by the National Cotton Batting Institute, is being used in increasing quantities for automobile seat cushions, and is expected to be used in other types of upholstery and bedding. Commercial production is expected to exceed 2½ million pounds in 1966.

Chemical engineers N. B. Knoepfler, H. K. Gardner, Jr., and H. L. E. Vix developed the new batting at the Southern utilization research laboratory in New Orleans, in cooperation with the Textile Waste Association, the National Cotton Batting Institute, the Foundation for Cotton Research and Education, and the National Cottonseed Products Association.



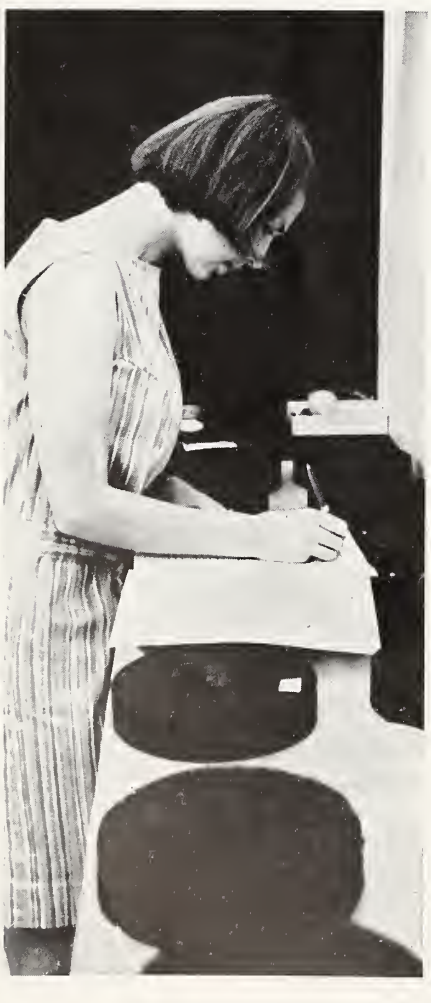
Improved cotton batting developed by ARS chemical engineers can be molded to any shape desired for use in upholstery. (Photo No. PN–1386)

The engineers greatly improved resilience by treating batting (60 percent cotton linters and 40 percent textile waste) with chemicals similar to those used to impart wash-wear properties to cotton textiles. Thus, the batting is better able to recover from compression. A latex added to the treating solution holds the fibers in position and helps prevent lumping and unevenness. ■



In Public Law 480 Research . . .
Finnish Scientists Learn

What Draws Beetles to Pine Trees



To test attractants extracted from pine trees, technician Helinä Turpeinen counts the number of pine bark beetles attracted by the substances. (Photo No. PN–1387)

FINNISH SCIENTISTS have isolated and identified the substance in pine trees that attracts one species of pine bark beetles.

Their discovery may lead to the development of a new method for controlling this and other insects, and may help plant geneticists to breed trees that do not contain the substances that attract insects.

Forest entomologist Esko Kangas and insect physiologist Vilho Perttunen directed the work, started in 1960 under a Public Law 480 grant awarded by ARS to the Institute of Agricultural and Forest Zoology of the University of Helsinki. Grants are made from local currencies paid by countries that receive U.S. surplus food.

To find and isolate the attractant, Kangas, Perttunen, and their coworkers made extracts from the bark, foliage, and wood of pine trees *Pinus silvestris* and made more than 4,000 separate attractant tests with more than 40,000 pine bark beetles.

They also analyzed numerous chemical substances known to exist in pine bark. and found that terpineol, a constituent of pine resin, is the same as the pure attractant which they isolated. Terpineol is produced commercially for use as a solvent for resins, gums, waxes, and oils.

Kangas and Perttunen are now using the attractant in field experiments as a means of luring pine bark beetles from pine trees into traps.

Before they began their research, there was no definite knowledge of what draws pine bark beetles to pine trees. With some other bark beetles, scientists think that a few insects may land on a certain tree by chance. These "pioneer" beetles then give off an odor that attracts a swarm of beetles to the tree.

From his own observations in nature, Kangas believed that trees gave off an odor that attracted pine bark beetles of the species *Blastophagus piniperda*. His research proved this theory to be correct.

The Finnish scientists found that the phloem of the bark—the natural

breeding place of the pine bark beetle—contains the attracting substance. Phloem was removed from bark in the winter before it could be infested by beetles, proving that pioneer beetles did not cause the attraction.

While still frozen so that no changes could occur in it, the phloem was shaved from the wood, powdered, and immersed in acetone. The mixture was then filtered and as much of the extract as possible gathered by compressing the residue.

To simulate nature, most of the experimental insects were collected during swarming flights in search of breeding places. They were kept at about 34 degrees F. until about a day before testing, when the temperature surrounding them was gradually raised to 68 degrees F., their normal swarming temperature. Some were collected by gathering infested pine stumps in the winter and storing at freezing temperature until beetles were needed.

Attractant tests were carried out in glass chambers covered with black cardboard, as beetles live in darkness until ready to swarm. Beetles were above false floors of pin-punctured paper. Below the false floor, scientists placed filter paper soaked in the fraction to be tested on one side of each chamber, and unsoaked paper on the other side.

Each test used 40 to 80 chambers with 10 beetles each, and lasted 3 hours. Laboratory workers counted the beetles at regular intervals to see how many went to the side with the attractant under it. Control tests were made with chambers with no attractant on either side.

The main attractant fraction, which chemist Helmer Oksanen isolated from 70 fractions, represents only 7 or 8 percent of the phloem. He divided this fraction into three subfractions, and divided the most powerful of these into three more subfractions. One of these contains the pure attractant. ■

SEMEN QUALITY TESTS

Valid for Group Evaluation But Not for Individual Bulls

A beef cattle breeder could easily be tossing hard-earned money down the drain if he sends a bull to the slaughterhouse just because the bull fails a single semen test.

ARS research indicates that microscopic evaluations of bull semen can help predict the average fertility of groups of bulls—but not the fertility of an individual animal.

This conclusion is based on semen evaluations of 232 Hereford, Angus, and Shorthorn bulls in studies at Crawford, Nebr., by beef cattle researchers J. N. Wiltbank and J. E. Ingalls of ARS, and W. W. Rowden of the Nebraska Agricultural Experiment Station.

The scientists rated semen collected by electrical stimulation on the basis of motility of sperm, concentration of sperm, and percentage of dead and abnormal sperm. Many commercial breeders use this type of semen test on their bulls prior to the breeding season. However, there is considerable controversy over whether tests of semen collected by electrical stimulation reveal the type of semen produced later in natural matings with cows; and if so, how great a relationship exists between appearance of sperm and their fertilizing ability.

Based on their semen evaluations, the scientists divided the bulls into "good" and "poor" groups. Within 3 days of the last evaluation, these bulls were mated to feedlot heifers. Results of natural matings and of the semen quality tests were consistent in comparing groups of bulls. One group of 10 "good" bulls successfully bred 67 percent of the heifers to which they were mated. A group of five "poor" bulls demonstrated only 45 percent fertility.

When applied to individual bulls, the "good" or "poor" labels generally were meaningless. One "poor" bull proved to be more fertile than 6 of the 10 "good" individuals; one "good" bull actually bred only 43 percent of the heifers to which he later was mated.

The semen test successfully predicted complete sterility in two bulls. No sperm was detected in their semen samples, and both were mated to 15 cows without a single conception. The same bulls, however, were remated a month or more later, and conception occurred in about 75 percent of the heifers used. The scientists speculate that the bulls had not reached sexual maturity at the time of the first breeding trial.

The researchers found, also, that semen from many bulls varied considerably in makeup from week to week. In the course of 3 weeks, 22 percent of the bulls changed 20 percent or more in overall fertility.

The scientists examined 11 specific indicators of semen quality, including seven types of abnormality such as sperm with coiled tails, lost tails, or abnormal heads. Individually, or combined into weighted equations, these characteristics proved to have little value for predicting a bull's fertility. ■

UNITED STATES GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS, WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

PENALTY FOR PRIVATE USE TO AVOID PAYMENT OF POSTAGE, $300 (GPO)

AGRISEARCH NOTES

Hitchhiker Named "Pestina"

ARS' hitchhiking girl-bug, used to symbolize foreign plant and animal pests and diseases that could sneak into this country on fruits, plants, and meats carried by travelers, has been named "Pestina."

The name was one of about 1,000 entered in a contest conducted by the Air Transport Association of America among the Nation's 200,000 airline employees.

First created in 1958, the girl-bug has been used as a standardized—but nameless—symbol since 1963.

She appears on agricultural quarantine notices shown on television and on literature distributed to travelers by airlines, steamship companies, and travel agents.

Water Loss—Estimate Too High

An article in the April issue of AGRICULTURAL RESEARCH stated incorrectly that the annual loss of water through cracks in concrete irrigation canals in Arizona is 20 million acre-feet. One million acre-feet per year is a more accurate loss estimate.

Diagnosing Similar Diseases

A physician or veterinarian can diagnose some diseases by examining a patient and checking a medical history. But many diseases look so much alike that only specific diagnostic tests can distinguish between them. This confusion may prevent correct diagnosis until it is too late to save the patient, or may prevent control measures based on knowledge of the source of the disease agent.

Nocardiosis, a serious disease of cattle, dogs, and man, is an example. It is easily confused with tuberculosis or fungus infections. Depending on what organs or tissues are invaded, nocardiosis can result in a wide variety of ailments. In cattle, these include mastitis, abortion, and pulmonary and generalized infections. Similar infections have been found in dogs and man, and the disease organism infects cats, goats, horses, and rodents on rare occasions.

Infections usually come from the environment rather than from contact between animals. The organism usually can be found in soil and most infections result from inhaling Nocardia-laden dust.

In the future, however, it may be possible to diagnose nocardiosis rapidly. Veterinarian A. C. Pier and chemist R. F. Keeler have developed a new diagnostic test at ARS' National Animal Disease Laboratory, Ames, Iowa.

The test enabled them to detect every case of nocardiosis in a group of experimentally infected cattle. It has also proved reliable in limited field trials with naturally infected cattle.

In the test, an antigen given off by the disease agent *Nocardia asteroides*, causes a reaction when inoculated into the skin of an infected animal or combined with the animal's blood serum in a test tube.

So far, the scientists don't know exactly where this antigen comes from. They know that it does not come from cell walls. This is important because there are antigens in the cell walls of Nocardia similar to those of the organism that causes tuberculosis. Using these would confuse the results of tests for the two diseases.

Pier and Keeler have developed chemical and physical methods for standardizing preparations of the test antigen so that enough can be made for field testing.

CAUTION: In using pesticides discussed in this publication, follow directions and heed precautions on pesticide labels. Be particularly careful where there is danger to wildlife or possible contamination of water supplies.

U.S. GOVERNMENT PRINTING OFFICE: 1966